

REMARKS

Claims 1-7 are currently pending in the application. No claims have been amended or canceled. Applicant respectfully requests reconsideration of the application in view of the following remarks.

Claims 1-5 and 7 stand rejected under rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,602,839 to Annapareddy et al. ("Annapareddy") in view of "Collective dynamics of 'small world' networks", to Watts et al. ("Watts").

Independent claim 1 discloses a system comprising a plurality of computing nodes interconnected to form a plurality of node clusters. Applicant respectfully submits that the cited combination of Annapareddy and Watts fails to teach, suggest, or render obvious at least one of the distinguishing features of independent claim 1, namely, cross-links are provided between node clusters and wherein the cross-links are selected such that the system comprises a small-world network. In addition, the cited combination of Annapareddy and Watts fails to disclose the small-world network comprising a substantially higher clustering coefficient of nodes in combination with a substantially lower characteristic path length between the nodes in comparison with a corresponding randomly-connected network.

Annapareddy is cited by the Office Action as disclosing a system comprising a plurality of computing nodes; however, the Office Action concedes that Annapareddy is silent regarding "...selecting the cross-links such that the system comprises a small world network ..." See Office Action, p. 2. Watts has been cited by the Examiner as supplying this deficiency of Annapareddy. Given the above, the Office Action suggests that it would have been an advantageous modification to "...the system disclosed by Annapareddy since it would have significantly reduced the average path length, resulting in reduced latency and more efficient routing on the network, since the average number of hops required to reach a distant node would be decreased."

Applicant first respectfully submits that there is no motivation to combine Annapareddy and Watts. Annapareddy discloses a multinode communication or multiprocessor network in which

messages are communicated from one node to another using an adaptive and dynamic routing scheme. The routing scheme includes two-level multi-path routing tables at each node to ensure efficient delivery of the messages. The routing scheme also includes a deflection counter in each message header to avoid endless rerouting of messages and an exponential back off and retry policy to avoid deadlocks. The network depicted in Figure 2 of Annapareddy is a substantially regularly-connected network having a high degree of interconnection and does not exhibit any of the characteristics of a small-world network.

Watts discloses an analysis and a mathematical description of the properties of “small world” networks. Watts discloses that the small world principle can be embodied in a variety of biological, technological, and social networks. Watts further discloses techniques for analyzing existing networks in order to assess the extent to which the existing networks embody the small world principle.

Applicant respectfully submits that the network taught by Annapareddy utilizes an adaptive and dynamic routing scheme which is applicable to prior art multi-processor networks. Annapareddy fails to disclose using novel physical network topologies such as, for example, the small-world network topology to overcome problems of latency and efficient routing. Annapareddy discloses a fully connected network having a substantially one-to-one connectivity which cannot be scaled. More specifically, combining the small world network design with the network design taught by Annapareddy would render the adaptive and dynamic scheme of Annapareddy unnecessary. Therefore, there would be no motivation to utilize the small world principle of Watts with a multinode communication or multiprocessor network in which messages are communicated from one node to another using an adaptive and dynamic routing scheme as disclosed in Annapareddy. In addition, Watts fails to disclose or suggest the possibility that a small world network principle may be employed as a tool in the design of improved networks, rather than merely as an analytical tool. While Watts provides some of the necessary mathematical tools, Watts fails to disclose a solution to the problem of scalability of multi-node computing systems.

Given the above, Applicant respectfully submits that there is no motivation to combine the teachings of Annapareddy and Watts as suggested by the Office Action. Indeed, even if the teachings of Annapareddy and Watts were somehow combined as suggested by the Office Action, the small world network design as claimed would render the adaptive and dynamic scheme of Annapareddy unnecessary.

In view of the foregoing, Applicant respectfully submits that the Examiner has failed to establish a *prima facie* case of obviousness under 35 § 103(a). In order to establish such a case, each of three requirements must be met. First, the reference or references, taken alone or combined, must teach or suggest each and every element recited in the claims. M.P.E.P. § 2143.03. Second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the references in a manner resulting in the claimed invention. *Id.* at § 2143.01. Third, a reasonable expectation of success must exist that the proposed modification will work for the intended purpose. *Id.* at § 2143.02. Here, the Examiner has failed to comply with all three requirements. Moreover, each of these requirements must “be found in the prior art, and not be based on applicant’s disclosure.” *Id.* at § 2143.

With respect to the first requirement, Applicant respectfully submits that the combination of Annapareddy and Watts fails to teach, suggest, or obviate each and every element recited in independent claim 1. Watts discloses a small-world principle and small-world network in general. Watts further discloses analysis techniques for assessing an extent to which a given network exhibits small-world properties. In addition, Watts discloses a random rewiring procedure which interpolates between a regular ring lattice and a random network. However, Watts fails to disclose a design technique, applicable to communication or computing networks, which could be used to generate a functional network in accordance with small world principles and achieving the object of massive scalability according to the Applicant’s invention. The additional insight required to develop and apply the small world principle as a design methodology in communications or computing networks is not disclosed by Annapareddy or Watts, either alone or in combination. The combination of Annapareddy and Watts fails to disclose a system comprising a plurality of

computing nodes having cross-links provided between node clusters wherein the cross-links are selected such that the system comprises a small-world network. Independent claim 1 embodies a design methodology for multi-node computing networks. On the contrary, Watts discloses methods of analyzing small-world networks along with an idealized construction utilized for the purpose of illustrating the analysis techniques.

With regard to the second requirement, the Examiner has provided absolutely no proper motivation to combine Annapareddy with Watts in the first place. The Examiner resorts to the vague and overly general statement that it would have been an advantageous modification to "...the system disclosed by Annapareddy since it would have significantly reduced the average path length, resulting in reduced latency and more efficient routing on the network, since the average number of hops required to reach a distant node would be decreased." Applicant submits that such a general statement is not a proper motivation and, therefore, the Examiner has failed to establish a *prima facie* case of obviousness. See *In re Zurko*, 258 F.3d 1379, 1386 (Fed. Cir. 2001) (determinations of *prima facie* obviousness, including motivation, must be supported by a finding of "substantial evidence").

In particular, it is an object of the present invention to provide a massively scalable multi-node computing system including a large number of processors in which each processor can communicate effectively with other processors without their locations. This object of the present invention is disclosed in independent claim 1. Independent claim 1 discloses a plurality of computing nodes having cross-links provided between node clusters wherein the cross-links are selected such that the system comprises a small-world network. Annapareddy is not concerned with the provision of a scalable multi-node computer system. In contrast, Annapareddy discloses an improved method and means for adaptively routing messages in a multi-node network. The routing method and means as disclosed in Annapareddy is independent of network topology. Applicant respectfully submits that, in the absence of substantial evidence, proper motivation to combine Annapareddy with Watts cannot be established merely by stating that certain advantages might be obtained ignoring the fact that Annapareddy teaches away from modifications to the network topology.

With regard to the third requirement, Applicant respectfully submits that the Examiner has failed to establish, again on the basis of substantial evidence, that a reasonable expectation of success exists that the proposed combination will work for the intended purpose. On the contrary, Applicant respectfully submits that it was not the case that a small world network was an obvious candidate for the design of a massively scalable computing architecture from the outset. In particular, Applicant's demonstration that it is possible to achieve a desired low characteristic path length which is invariant at any scale over many orders of magnitude is a result of Applicant's insight and analysis which is a unique feature of the present invention. The present invention demonstrates the clear advantages of applying small-world principles described in Watts to the design of multi-node communication and computing networks. Applicant respectfully submits that the motivation to apply small-world principles in this manner, as well as demonstration of the benefits of doing so, are found in the present invention and not in the prior art references of Annapareddy and Watts.

For all the foregoing reasons, Applicant respectfully submits that independent claim 1 distinguishes over the cited combination of Annapareddy and Watts. Withdrawal of the rejection of independent claim 1 is respectfully requested.

Dependent claims 2-5 depend from and further restrict independent claim 1 in a patentable sense. Applicant respectfully submits that, for at least the reasons set forth above with respect to the rejection of independent claim 1, dependent claims 2-5 distinguish over the cited combination of Annapareddy and Watts and are in condition for allowance. Withdrawal of the rejection of dependent claims 2-5 is respectfully requested.

In addition, Applicant respectfully submits the cited combination of Annapareddy and Watts fails to teach, suggest, or render obvious at least one of the distinguishing features of dependent claim 4, namely, wherein an average path length between the nodes is less than 2.0. In addition, Applicant respectfully submits the cited combination of Annapareddy and Watts fails to teach, suggest, or render obvious at least one of the distinguishing features of dependent claim 5, namely, wherein an average path length between the nodes is between 1.5 and 1.7. The

combination of Annapareddy and Watts fails to disclose this result. For this additional reason, dependent claims 4-5 distinguish over the cited combination of Annapareddy and Watts. Withdrawal of the rejection of dependent claims 4-5 is respectfully requested.

Independent claim 7 discloses a scalable computer system. Applicant respectfully submits that the cited combination of Annapareddy and Watts fails to teach, suggest, or render obvious at least one of the distinguishing features of independent claim 7, namely, cross-links are provided between nodes of different clusters in a network and wherein the cross-links are selected such that the system comprises a small-world network. In addition, the cited combination of Annapareddy and Watts fails to disclose the small-world network comprising a substantially higher clustering coefficient of nodes in combination with a substantially lower characteristic path length between the nodes in comparison with a corresponding randomly-connected network. Additionally, Applicant submits that claim 7 patentably distinguishes over Annapareddy and Watts for similar reasons to those discussed above with respect to independent claim 1. Applicant respectfully requests that the rejection of independent claim 7 as unpatentable over Annapareddy in view of Watts be withdrawn.

Claims 6 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Annapareddy in view Watts and further in view of U.S. Patent No. 5,859,975 to Brewer et al. ("Brewer").

Independent claim 6 discloses a large scale computer system. Applicant respectfully submits that the cited combination of Annapareddy, Watts, and Brewer fail to teach, suggest, or render obvious at least one of the distinguishing features of independent claim 6, namely, cross-links are provided between nodes of different clusters in a network and wherein the cross-links are selected such that the system comprises a small-world network. In addition, Annapareddy, watts, and Brewer fail to disclose the small-world network comprising a substantially higher clustering coefficient of nodes in combination with a substantially lower characteristic path length between the nodes in comparison with a corresponding randomly-connected network. Additionally, Applicant submits that claim 6 patentably distinguishes over Annapareddy and Watts for similar reasons to

those discussed above with respect to independent claims 1 and 7. Brewer fail to cure the deficiencies of Annapareddy and Watts noted above. Applicant respectfully requests that the rejection of independent claim 6 as unpatentable over the combination of Annapareddy, Watts, and Brewer be withdrawn.

In view of the above amendments, Applicant believes the pending application is in condition for allowance.

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Respectfully submitted,

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